NEX-GDDP: Global Daily Downscaled Projections for Studies of Climate Change Impacts

1. Intent of This Document and POC

1a) This document provides a brief overview of the NASA Earth Exchange (NEX) Global Daily Downscaled Projections (NEX-GDDP) dataset, and is intended for users of the dataset who wish to apply the NEX-GDDP dataset in studies of climate change impacts. This document summarizes essential information needed for accessing and using information contained within the NEX-GDDP dataset. References and additional information are provided at the end of this document

This NASA dataset is provided to assist the science community in conducting studies of climate change impacts at local to regional scales, and to enhance public understanding of possible future climate patterns and climate impacts at the scale of individual neighborhoods and communities. This dataset is intended for use in scientific research only, and use of this dataset for other purposes, such as commercial applications, and engineering or design studies is not recommended without consultation with a qualified expert. Community feedback to improve and validate the dataset for modeling usage is appreciated. Email comments to bridget@climateanalyticsgroup.org.

Dataset File Name: NASA Earth Exchange (NEX) Global Daily Downscaled Projections (NEX-GDDP), https://cds.nccs.nasa.gov/nex-gddp/

1b) Technical points of contact for this dataset:

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2. Data Field Descriptions

CF variable name, units:	*Tasmin* Daily Minimum Near-Surface Air Temperature Degrees Kelvin
Spatial resolution:	0.25 degrees x 0.25 degrees (25 km x 25 km)
Temporal resolution and extent:	Monthly from 1950-01-01 00:00:00 to 2099-12-31 11:59:59 Units are in days since 1950-01-01 00:00:00
Coverage:	West Bounding Coordinate: -125.02083333 East Bounding Coordinate: -66.47916667 North Bounding Coordinate: 49.9375 South Bounding Coordinate: 24.0625

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CF variable name, units:	*pr* Precipitation (daily precipitation rate) kg m-2 s-1
Spatial resolution:	0.25 degrees x 0.25 degrees (25 km x 25 km)
Temporal resolution and extent:	Monthly from 1950-01-01 00:00:00 to 2099-12-31 11:59:59 Units are in days since 1950-01-01 00:00:00
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3. Data Origin and Methods

3.1. Introduction

The NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) dataset is comprised of downscaled climate scenarios for the entire globe that are derived from the General Circulation Model (GCM) runs conducted under the Coupled Model Intercomparison Project Phase 5 (CMIP5). The scenarios include the historical experiment and the Representative Concentration Pathway (RCP) 4.5 and 8.5 experiments developed for the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5). The dataset is an ensemble of projections from 21 models and provides daily estimations (1950-2005 for historical experiments, 2006-2099 for RCP experiments) of precipitation (pr), maximum temperature (tasmax), and minimum temperature (tasmin) at 1Ž4-degree horizontal resolution over the entire globe. The total data volume is approximately 11 terabytes.

3.2 Methods

The downscaling method used to create the NEX-GDDP dataset is a daily variant of the monthly Bias Correction/Spatial Disaggregation (BCSD) method described in Wood et al. (2002, 2004). This variant method (Thrasher et al., 2012) uses daily GCM output to produce the corresponding daily downscaled values. In this application, the bias correction and downscaling utilized the 1Ž4-historical gridded daily observations from 1950-2005 by Sheffield et al. (2006). In addition, instead of first interpolating the raw GCM output from each model to a common grid, as has been done in previous ensemble downscaling applications, the bias correction step in this application was performed at the native GCM grid resolution.

4. Considerations and Recommended Use

The NEX-GDDP output is comprised of 21 historical experiments (1950-2005, 56 years/experiment) and 42 RCP future experiments (21 each for RCP 4.5 and RCP 8.5, 2006-2099, 94 years/experiment). The output is contained in yearly files in netCDF-4 classic format. Precipitation file sizes are ~550 MB, and temperature file sizes are ~780 MB. Therefore, the data volume from each model (three variables, three experiments each) is ~500 GB. The data volume of the entire ensemble is approximately 11 terabytes.

5. Credits and Acknowledgements

Please add the following acknowledgement to any publications that result from use of this dataset:

> Climate scenarios used were from the NEX-GDDP dataset, prepared by the Climate Analytics Group and NASA Ames Research Center using the NASA Earth Exchange, and distributed by the NASA Center for Climate Simulation (NCCS).

6. References

Sheffield J, Goteti G, Wood EF (2006) Development of a 50-yr high-resolution global dataset of meteorological forcings for land surface modeling. J. Climate 19 (13): 3088-3111.

Thrasher B, Maurer EP, McKellar C, Duffy PB (2012) Technical Note: Bias correcting climate model simulated daily temperature extremes with quantile mapping. Hydrology and Earth System Sciences 16: 3309-3314.

Wood AW, Maurer EP, Kumar A, Lettenmaier DP (2002) Long-range experimental hydrologic forecasting for the eastern United States. Journal of Geophysical Research-Atmospheres 107.

Wood AW, Leung LR, Sridhar V, Lettenmaier DP (2004) Hydrologic implications of dynamical and statistical approaches to downscaling climate model outputs. Climatic Change 62: 189-216.

7. Dataset and Document Revision History

Rev 0 – 26 June 2015 – Document created. This is a new document/dataset.

Table 1. CMIP5 models included in downscaled archive

ACCESS1-0	CSIRO-MK3-6-0	MIROC-ESM
BCC-CSM1-1	GFDL-CM3	MIROC-ESM-CHEM
BNU-ESM	GFDL-ESM2G	MIROC5
CanESM2	GFDL-ESM2M	MPI-ESM-LR
CCSM4	INMCM4	MPI-ESM-MR
CESM1-BGC	IPSL-CM5A-LR	MRI-CGCM3
CNRM-CM5	IPSL-CM5A-MR	NorESM1-M

APPENDIX I – WORKING WITH NETCDF FILES

To work with the NEX-GDDP netCDF files you will need to have the netCDF libraries installed (https://www.unidata.ucar.edu/software/netcdf/docs/netcdf-install.html). If you are installing and building the libraries, be sure to include the ncdump utility.

Once the libraries are installed, you can use **ncdump** to get metadata information using the **–h** option. (Tip: It's very important not to forget to include **–h** when using the **ncdump** command.)

this command will display the metadata contained in the netCDF header for each file
% ncdump –h *filename*

For users who prefer a GUI interface, **ncbrowse** is a useful tool for browsing both metadata and data contents of netCDF files (http://www.epic.noaa.gov/java/ncBrowse/).

The Python netCDF4 libraries (http://code.google.com/p/netcdf4-python/) contain a number of highly useful functions for working with netCDF files. **numpy** (http://www.numpy.org/) is also highly recommended and provides a number of very useful statistical functions.

Once these libraries are installed, the following commands will be useful for working with the CMIP5 netCDF files in python.

Python commands:

to import the modules
% import netCDF4,numpy

to open a netCDF data file
the second argument 'r' means readonly, use 'a' to append/modify a file

% ds = netCDF4.Dataset(infilename,'r')

the 'variables' function will list the variables that are in the file
% ds.variables

to retrieve information on the shape of a specific variable (in this case, 'pr' or precipitation)
% ds.variables['pr'].shape

to retrieve first timestep from that variable
% pr0 = ds.variables['pr'][0]

to determine what value was used as a fill value for the variable
% pr.fill_value

to determine the minimum value

% numpy.min(pr0)
# to determine the maximum value
% numpy.max(pr0)

to extract a subset of the full dataset contained in the file
% prSub = pr0[10:50,20:30]

to close the file
% ds.close()